Effect of Materials on Aging Rates in Wire Chambers Operated with DME

(title assigned)

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The effects of various materials on aging rates of wire chambers filled with dimethylether gas (DME) have been investigated. Silicone compounds and some urethane polymers were observed to dramatically increase aging damage in test chambers. All other materials tested did not appear to significantly affect the measured damage rates.

Summary of Talk: The TWIST drift chambers (TRIUMF E614) are expected to make precise and efficient position measurements of both the polarized surface muons which stop in a target in the middle of the detector stack, and the resulting decay electrons which spiral out in the 2 Tesla magnetic field. Dimethylether (DME) was chosen as the filling gas due to its small Lorentz angle, high primary ionization, low Z, and wide efficiency plateau. Because of concerns about DME aging and attack, materials and devices proposed for use in the drift chambers and gas system which would be in contact with the gas stream were subjected to laboratory aging tests. Single-wire wire chambers (SWC's) were used to measure aging damage. Two adjacent independent SWC's were milled out of a single piece of 1.2 cm thick aluminum bar stock. The active volume of each SWC was 20 cm long, 1.2 cm square cross section, with a central 20 μm gold-plated tungsten anode wire and aluminised mylar cathode foils. Five pairs of SWC's were placed in a stack separated by 6 mm thick lead collimator sheets and illuminated by a single 10 mCi ^{90}Sr source, such that only the central 2 cm of each SWC was directly exposed to the source. Typical aging current densities ranged from approximately 100 nA/cm-wire at the top of a stack to 10 nA/cm-wire for the SWC's at the bottom. Materials to be tested were put inside copper canisters which were then inserted in the input gas line approximately 20 cm from the input port of each SWC. Devices to test, such as valves, flowmeters, etc., were inserted at similar locations. A few SWC's in each stack had no test materials inserted and one of these was left with zero high voltage during aging to allow "null" comparisons. The SWC's were aged at a nominal gasgain of $5 \cdot 10^4$ for 3 to 6 months to total accumulated charges ranging from 0.10 to 1.8 C/cm-wire. Once each week the ^{90}Sr source would be removed and the gas changed to Argon/Ethane 50:50 to provide more precise pulse height spectra. An ^{55}Fe x–ray source collimated to 1 mm was then used to measure the average pulse height at the centre of the irradiated region and at locations 4 cm upstream and 5.5 cm downstream of the centre for each SWC. Detailed pulse height profiles at 1 cm intervals along the anode wire were then measured for 3 or 4 of the SWC's. These measurements were used to reveal changes and estimate damage rates in the SWC's. After completion of the measurements the gas flow was changed back to DME, and the ^{90}Sr source installed for further aging. Materials being tested were inspected for any obvious visual or functional changes at the end of the entire aging period. Various epoxies, adhesives, sealants, elastomers, plastics, valves, and other devices were tested. Of the 49 tests completed, 25 revealed pulse height loss of less than 10%/C/cm-wire and most of these were consistent with zero apparent damage. Another 7 tests caused damage rates from 10% to 50%/C/cm-wire. The remaining 17 tests resulted in damage rates ranging from 70% to 5600%/C/cm-wire. This latter group was dominated by materials or devices containing silicone rubbers, adhesives or lubricants. Urethane rubbers and UV activated urethane methacrylate glues also caused extremely high damage rates. There was no convincing evidence of enhanced damage rates with any of the other materials tested, with the possible exception being Buna-N, where damage rates of 14% and 43%/C/cm-wire were recorded in two separate tests. A discolouration of the internal surface of the zinc body of a pressure regulator was the only observed evidence of changes to materials tested caused by prolonged exposure to DME. A 40 cm^2 area of a complete drift chamber module constructed with "approved" materials was aged at a 60 nA/cm-wire rate to a total accumulated charge of 0.311 C/cm-wire. No aging damage was observed in the irradiated area.